Analyzing Long-Run Energy-Efficiency Potential in California

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Project Overview

- Develop long-run estimates of EE potential for CA's residential electric sector
- Establish process that could be replicated for other electric and natural gas buildings and industrial sectors
- Inform BEAR and related analyses
- PIER EA Climate Change, CIEE Administered
- Alan Sanstad, LBNL PM

Why Long-Run EE Forecasts?

- CA Climate Change Initiative
  - Emission reduction targets
    - 2000 levels by 2010
    - 1990 levels by 2020
    - 80% below 1990 levels by 2050
- Achieving targets will require combination of mitigation strategies
- How much contribution can efficiency in buildings and industrial sectors provide?

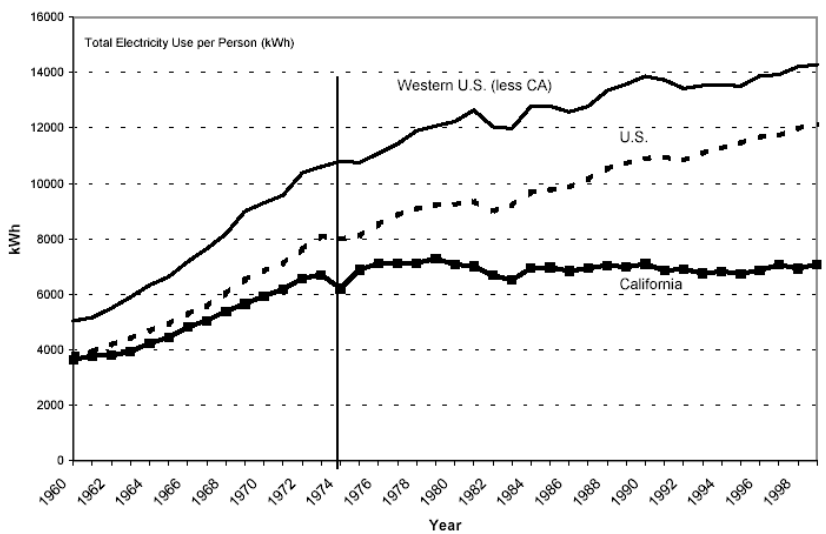
Emissions and Consumption

- CA's GHG emissions:
  - Transportation (41%) + Ag/Forestry (8%) = ~50%
  - Power, Industrial, and Buildings = ~50%;
    - Electric power ~20%; Industrial ~23%; Residential & Commercial ~7%
    - Most of power sector serves buildings & industrial
- Buildings and industrial emissions a function of electric, gas, and other fuel consumption
- Consumption a function of end use service demand

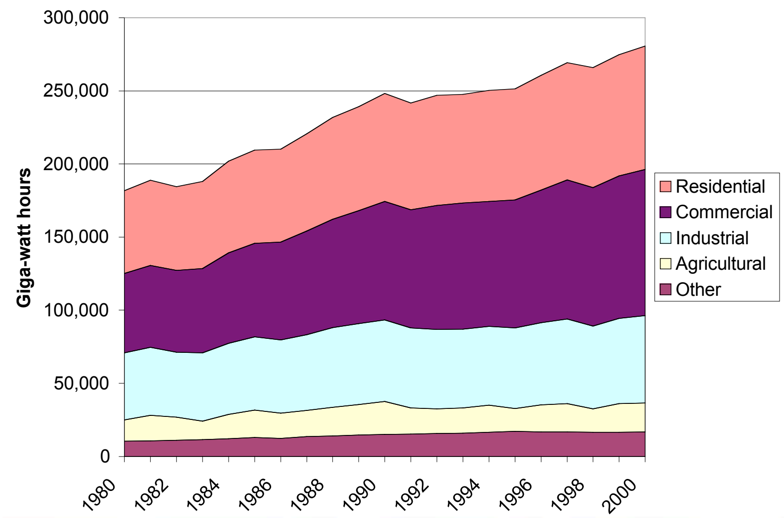
CA's Historic Efficiency Policies

- Title 24 Building Standards
- Title 20 Appliance Standards
- Utility programs
- Energy crisis programs

- *Per capita electric use held constant, efficiency increased*



- *But total use grew @2%/yr*
  - …Though well below national avg.



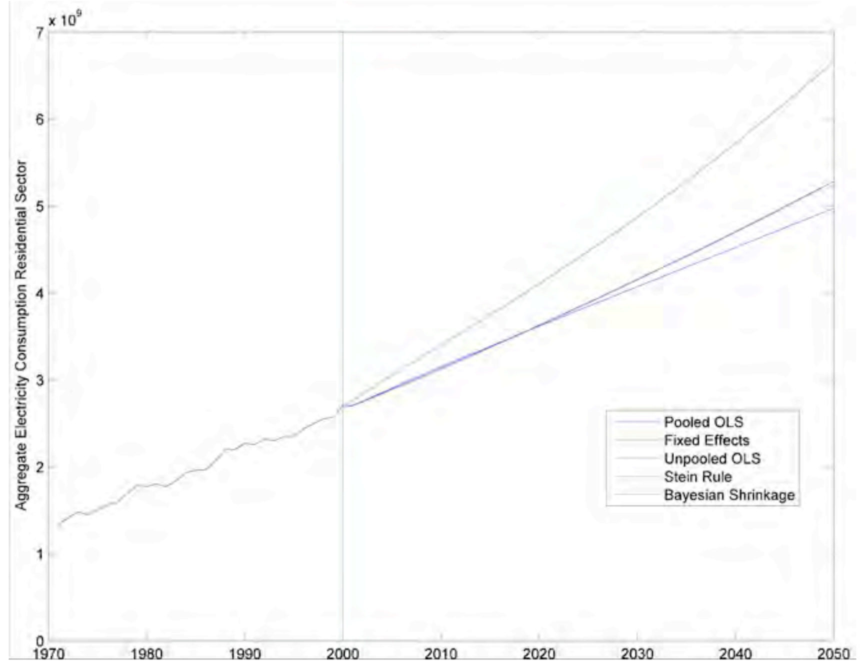
Forecasting Consumption & Efficiency

- Policy efforts to improve efficiency levels will continue
  - CPUC and EAP Goals for 2006-2008; CEC next round of standards; AB 549
- Common forecasting methods
  - Econometric models
  - End use forecasting models
  - Bottom up technology adoption models
  - Combined methods

Econometric Approach

Empirical Approach:

- Aggregate Residential Energy Demand
- Inform forecasts using 50 state data
- Estimate response coefficients
- Basis for simulation



Empirical Per Capita Demand Specification:

$$q_{jit} = \alpha_i + \beta_1 q_{jit-1} + \beta_2 y_{it} + \beta_3 y_{jit-1} + \beta_4 p_{jit} + \beta_5 p_{jit-}$$

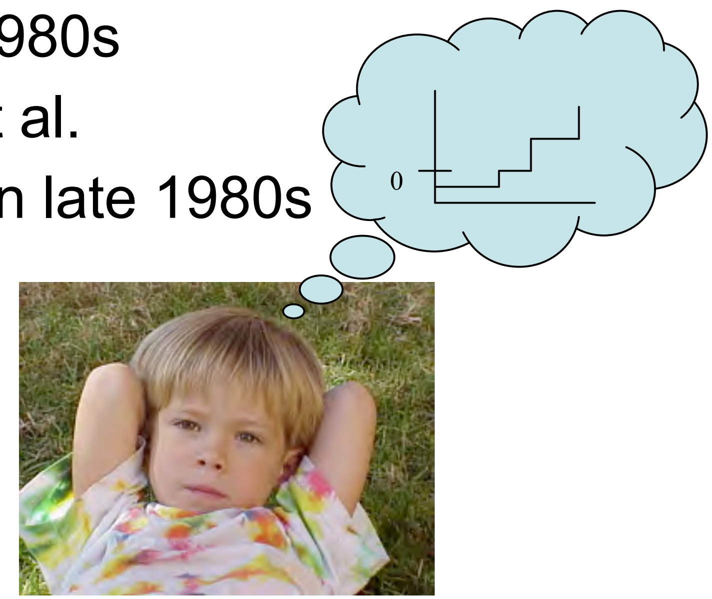
$$+\beta_6 p_{:jit} + \beta_7 HDD_{it} + \beta_7 CDD_{it} + \eta$$

Contributions of Econometric Analysis

- Separate out impact of aggregate programs and standards
- Incorporate Information from similar states
- Methodological Advance specific to State Level Forecasting
- Combine information from bottom up and econometric approach to construct boundaries of predictions

Thumbnail History of Bottom UP EE Studies

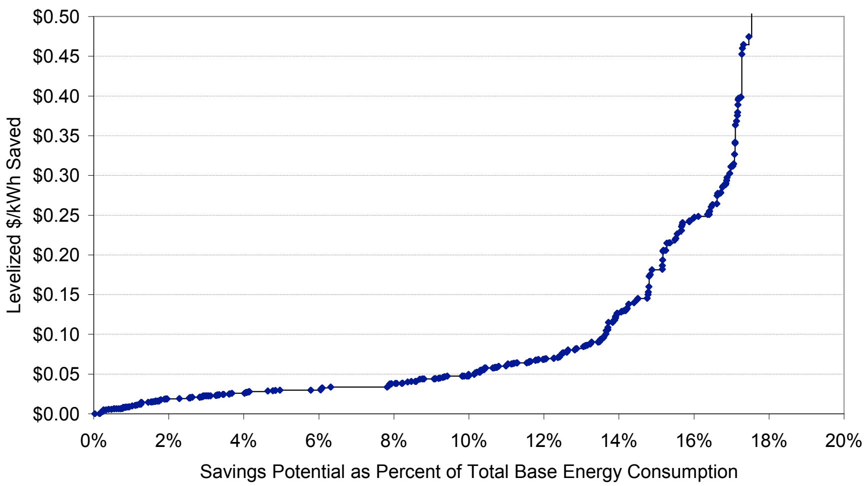
- Initial supply curve studies in early 1980s
  - Meier, Rosenfeld, Sant, Lovins,et al.
- Many comprehensive utility studies in late 1980s
  - Dozens of utility-specific/regional
  - Many models developed
- Early 1990s focus on inputs to IRP
  - Process peaked by 1994
- Very few studies post 1996
- Significant work by national labs in late 1990s
  - Occurred within greenhouse gas studies
- Surge in utility studies since 2001



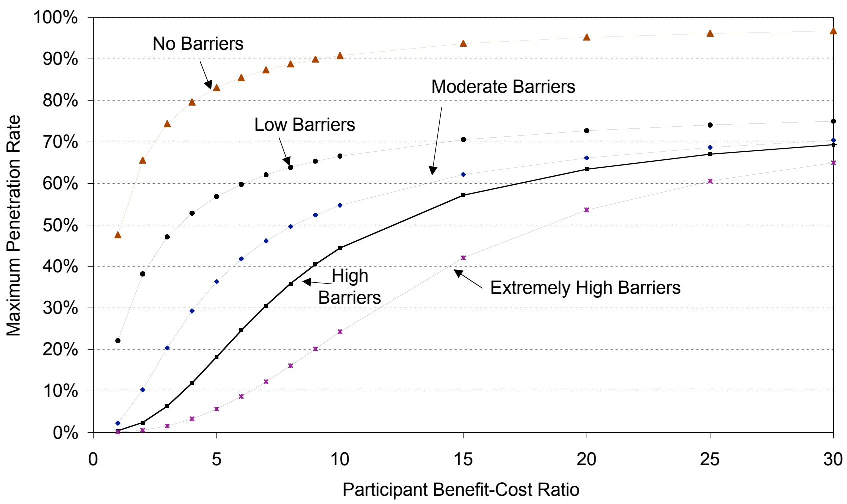
Bottom Up Approaches

- Technology-specific costs, efficiencies, features
- Base forecasts
- Detailed stock data/turnover

- Total potential via technology supply curves



- Predicted impacts over time via adoption modeling



Limitations to Methods

- Bottom Up
  - Need for detailed technology-specific data
  - Need for highly disaggregated market data
  - Difficulty predicting technology-specific adoption
  - Limited focus on non-efficiency consumption drivers
- Econometric
  - Dependence on past trends
  - Limits of time series data on program/policy effects
  - Lack of physical characteristics

Approach to Estimating Long-Run Efficiency Potential

- Timeframe: 2020 and 2050
- Use end use framework
- Assess emerging techs and tech frontiers
- Simplify/stylize bottom up tech detail
- Use scenario analysis
- Use econometrics to inform scenarios

Approach to Estimating Long-Run Efficiency Potential (cont.)

- End use consumption function of:
  - Service level, efficiency, saturation, households
- Scenario analysis on all key factors
- Scenarios:
  - Efficiency
    - Costs and levels
      - Interviews, literature, physical constraints
    - Fuel prices
    - Policy effects
  - Service levels
    - Size
    - Features
    - Policy effects

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Goals

- Increase understanding of:
  - CA residential consumption trends
  - Importance of service level and units
  - Range of policy and price effects
  - Contribution of efficiency to GHG mitigation
- Develop approach to expand to other sectors and fuels
- Inform BEAR and other long-term economic analyses